Question	Answer	Marks	Guidance
1	$e^{-2.3}(\frac{2.3^2}{2}+\frac{2.3^3}{3!}+\frac{2.3^4}{4!})$	M2	M1 for one term wrong or one end error or 1 – P(2, 3, 4)
	= 0.585 (3 sf)	A1	
		3	

Question	Answer	Marks	Guidance
2(i)	$z = 1.96$	B1	seen
	$330.1 \pm z \times \frac{4.8}{\sqrt{180}}$	M1	Must be of correct form. Any z
	= 329.4 to 330.8 (1 dp)	A1	Must be to 1 dp. Must be an interval.
		3	
2(ii)	Yes, because vol of all cans not stated to be normal	B1	Or Yes, population not stated to be normal
		1	

Question	Answer	Marks	Guidance
3	$E(T) = 2 \times 250 + 5 \times 160 \ (= 1300)$	B1	
	$Var(T) = 2 \times 10 + 5 \times 9 \ (= 65)$	B1	
	$\frac{1310 - '1300'}{\sqrt{'65'}}$ (= 1.240)	M1	Standardise using their values (must come from a combination attempt). Ignore cc
	$1 - \phi('1.240')$	M1	Correct area consistent with their working
	= 0.1075	A1	Allow 0.107 to 0.108 (no errors seen)
		5	

Question	Answer	Marks	Guidance
4(i)	$\int_0^a \frac{k}{(x+1)^2} dx = 1$	M1	Any attempt integ f(*x*) and = 1. Ignore limits
	$-\left[\frac{k}{(x+1)}\right]_0^a = 1$ $-k(\frac{1}{a+1} - 1) = 1$	M1	Attempt subst correct limits into correct integral
	$k \times \frac{a}{a+1} = 1$ and $k = \frac{a+1}{a}$ **AG**	A1	No errors seen
		3	

Question	Answer	Marks	Guidance
4(ii)	Max time allowed by model (for runners to finish)	B1	Allow: All runners finish in time a or less or Longest time (taken by any runner) oe
		1	
4(iii)	$\frac{a+1}{a}\int_0^{0.5}\frac{1}{(x+1)^2}\,dx = \frac{3}{4}$	M1	Attempt integ f(x) and $= \frac{3}{4}$; ignore limits oe. Condone missing / incorrect k
	$-\frac{a+1}{a}\left[\frac{1}{(x+1)}\right]_0^{0.5} = \frac{3}{4}$ $-\frac{a+1}{a}(\frac{2}{3}-1) = \frac{3}{4}$	M1	Attempt subst correct limits into correct integral. Condone missing / incorrect k
	$a = 0.8$ oe	A1	
		3	

Question	Answer	Marks	Guidance
5(i)	$\hat{\mu} = \frac{126}{70}$ or $\frac{9}{5}$ or 1.8 oe	B1	
	$\Sigma x^2 f = 286$	B1	Seen or implied
	$\text{Est}(\sigma^2) = \frac{70}{69}(\frac{\Sigma x^2 f}{70} - '1.8'^2)$	M1	oe attempted
	= 0.858 or 296 / 345	A1	Note: Final answer for var 0.846 (biased) and no working implies B1 for 286
		4	

Question	Answer	Marks	Guidance
5(ii)	H_0: $\mu = 1.9$ H_1: $\mu < 1.9$	**B1**	Or 'pop mean'; not just 'mean'
	$\frac{1.8-1.9}{\sqrt{\frac{'0.858'}{70}}}$	**M1**	Standardise with their values from **(i)**. Must have sqr 70. No SD / Var mix
	$= -0.903$	**A1**	Accept ±
	$0.903 < 1.645$	**M1**	comp 1.645 allow comp 1.96 if H_1: $\mu \neq 1.9$ or comp $1 - \phi$('0.903')=0.182 or 0.183 with 0.05 (or 0.025 if H_1: $\mu \neq 1.9$)
	No evidence that mean no courts in S is less than in N	**A1ft**	No contradictions. ft their 0.903, but not comp 1.96 i.e. no ft for a 2 tail test Accept cv method: cv = 1.718 M1A1 1.718 < 1.8 M1 conclusion A1 (cv centred on 1.8 gives 1.982 M1A1 and M1 for 1.982 > 1.9 A1 conclusion)
		5	
5(iii)	Type II because H_0 was not rejected	**B1ft**	ft their conclusion, i.e. if H_0 rejected, 'Type I because H_0 rejected' B1 Answer must be consistent with their conclusion. No conclusion in **(ii)** will score B0
		1	

Question	Answer	Marks	Guidance
6(i)	H_o: $p = 0.15$ H_1: $p < 0.15$ $(N(60 \times 0.15, 60 \times 0.15 \times 0.85))$ $= N(9, 7.65)$	**B1**	Accept H_0: $\mu = 9$ H_1: $\mu < 9$ Use of Normal approximation: $(N(0.15, \frac{0.15\times0.85}{60}))$ $= N(0.15, 0.002125)$
	$\frac{6.5-'9'}{\sqrt{'7.65'}}$	**M1**	For standardising (or $\frac{\frac{6}{60}+\frac{0.5}{60}-'0.15'}{\sqrt{'0.002125'}}$ = –0.904) Allow wrong or no cc
	= –0.904	**A1**	Accept ±
	'0.904' < 1.282	**M1**	Valid comparison of z values or ϕ('–0.904')= 0.183 > 0.1 ft their 0.904
	No evidence train late less often	**A1ft**	Use of Bin (60,0.15) to give Pr (< = 6) = 0.1848 M1A1 Valid comparison with 0.1 M1 Conclusion A1ft
		5	
6(ii)	$0.1 + z \times \sqrt{\frac{0.1\times0.9}{60}} = 0.150$	**M1**	For $\sqrt{(0.1 \times 0.9 / 60)}$ seen
		M1	for $0.1 + z \times ... = 0.150$ or $2z... = 0.1$
	$z = 1.291$	**A1**	
	ϕ('1.291') (= 0.90(16))	**M1**	for correct method to find α
	$\alpha = 80$	**A1ft**	ft their z. Must be a +ve non-zero integer < 100
		5	

Question	Answer	Marks	Guidance
7(i)	$e^{-5.6} \times \frac{5.6^3}{3!}$	M1	Allow any λ
	= 0.108 (3 sf)	A1	
		2	
7(ii)	$P(X=2 \ \& \ Y=1) = e^{-2.1} \times \frac{2.1^2}{2} \times e^{-3.5} \times 3.5$ (0.2700 × 0.10569 = 0.028538)	M1	
	$\frac{P(X=2 \ \& \ Y=1)}{P(X+Y=3)}$ attempted $= \frac{'0.028538'}{'0.108234}$	M1	For attempt at fraction with their **(i)** as denominator or $\frac{2.1^2}{2} \times 3.5 \div \frac{5.6^3}{3}$ M2
	= 0.264 (3 sf)	A1	
		3	

Question	Answer	Marks	Guidance
7(iii)	Var(X) = 2.1	**B1**	soi
	$\bar{X} \sim \text{N}(2.1, \frac{2.1}{100})$ or N (210,210)	**B1**	soi B1 for N(2.1, ...)
		B1	B1 for $\frac{2.1}{100}$ oe Standardise with their values. Allow with or without cc or with incorrect cc
	$\frac{2.2-2.1}{\frac{\sqrt{2.1}}{\sqrt{100}}}$ oe $(220-210)/\sqrt{210}$ (= 0.690)	**M1**	or $\frac{2.2+0.5\div100-2.1}{\frac{\sqrt{2.1}}{\sqrt{100}}}$ or $(220.5-210)/\sqrt{210})$ (= 0.725) no mixed methods
	1 – ϕ('0.690')	**M1**	Correct area consistent with their working or 1 – ϕ('0.725')
	= 0.245 (3 sf)	**A1**	= 0.234 (3 sf)
		6	